Inhalation Therapy

JOURNAL OF THE
AMERICAN ASSOCIATION
OF
INHALATION THERAPISTS

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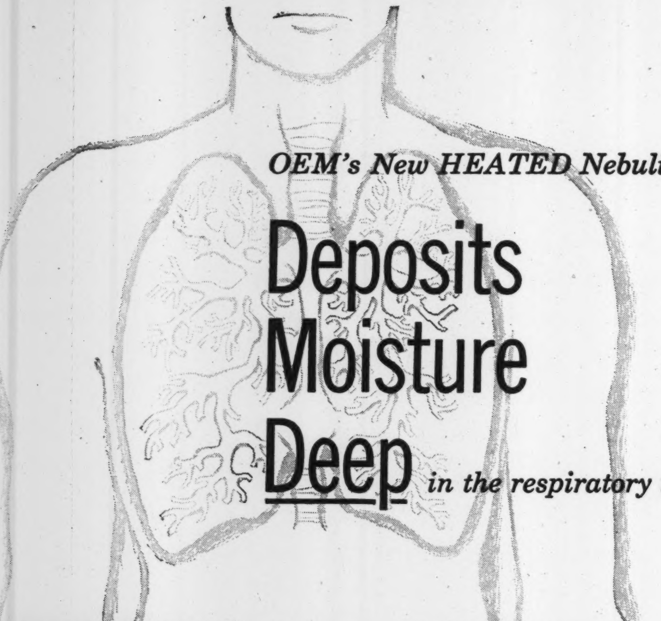

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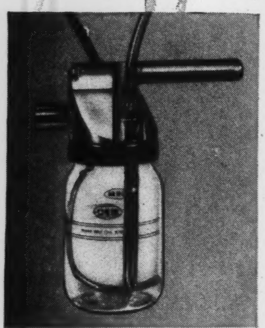

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******An Aerosol Method of Producing Bronchial Secretions in Human Subjects; a Clinical Technique for the Detection of Lung Cancer,*** **Hylan A. Bickerman, MD, FCCP: Edith E. Sproul, MD, and Alvan L. Barach, MD, FCCP. Paper read before 23rd annual meeting of American College of Chest Physicians in New York City, June 15, 1957.**

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AMERICAN ASSOCIATION OF INHALATION THERAPISTS

"Inhalation Therapy"

"Inhalation Therapy" is the official publication of the American Association of Inhalation Therapists, an organization of therapy technicians working in hospitals, for firms providing emergency therapy service and for municipal organizations. The Association is sponsored jointly by the American College of Chest Physicians and the American Society of Anesthesiologists. Contents include news and information pertinent to the profession including medical research, operative techniques, and practical administration.

CONTENTS

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Editorial

Standards

THE lack of adequate standards is one of the greatest causes of controversy and difficulty, in a number of ways. We need standardization not only of equipment and of methods, but also—at least to a certain extent—of personnel training. Only in this way is it possible to assure the patient of service of a uniform high quality.

Examples of difficulties arising from lack of standards are supplies and materials that prove unsuitable because they have not been properly specified, or goods that do not live up to manufacturer's representations.

Lack of at least a relatively standardized procedure for operation of equipment leads to such troubles as CO_2 build-up in tents where oxygen input is only 7 liters per minute—an adequate flow for a catheter.

As an example of the absence of standardization in the preparation of personnel, we find persons administering inhalation therapy in different parts of the country with qualifications ranging from those who may have started with no training at all and with not even a full high school education, to those who have complete formal training courses in one or another of the few institutions now offering them. It is clear that the doctor's order for a given type of therapy is not going to be carried out with the same degree of efficacy (other things being equal) by the one as it is by the other. It is also clear that the doctor who needs the consultation of a professional paramedical specialist in cases where other than routine inhalation therapy is indicated is not going to get satisfaction from the untrained individual.

Many manufacturers have done much to simplify matters by standardizing their equipment. Only in recent years, the "pin indexing" system was brought into use, whereby serious accidents which could arise from erroneously changing the positions of different gases on anesthesia apparatus are now automatically avoided. There is also at the present time a similarity in appearance and operation of such equipment as oxygen regulators, humidifiers, etc., which not many years ago were supplied in a perplexing assortment of styles and fittings.

However, in setting up standards of any sort, the human element is a much more difficult one to deal with than the technical. The standardization of equipment, while not yet at its most fully developed state, has certainly progressed farther than that of methods or of personnel training.

Because of the importance of human relationships, the national standardizing bodies and other experienced groups take great pains that each standard shall represent the consensus of feeling of those concerned with its subject matter. This is accomplished by direct representation of all interested groups upon the committee charged with formulation of the standard.

It is well to remember in establishing procedures or "standards" for general use in hospitals, that the more simple we make them, the better and more consistent will be the therapy received by the patient. If we specify definite flow and concentration ranges for each piece of equipment (unless otherwise ordered by the physician) in these procedures, there will be a more thorough understanding among all employees, and therefore better patient care. All techniques, such as how to keep the airways patent, should be well outlined and explained to all who will be dealing with the patient.

Though it is a separate subject by itself, standards for preparation of personnel should also be touched upon in any discussion of standards in inhalation therapy.

In many of our hospitals throughout the country, ancillary personnel are setting up inhalation therapy equipment and operating it on a more or less hit-or-miss basis. Often such "inhalation therapy" is of little therapeutic value, and can be down-right damaging, while costing the patient as much as or more than good quality therapy administered by a competently run department.

It is advisable that the American Association of Inhalation Therapists seriously consider the essentials necessary for acceptable preparation for the practice of inhalation therapy. A committee or a person should be appointed to work with the American Hospital Association and our sponsors to establish standards for the administration of inhalation therapy in all AHA-accredited hospitals.

The organization is working toward having included in the accreditation evaluation of a hospital a consideration of the employment of qualified therapists. To be able to do this, it will be necessary to obtain some method of professional evaluation of each therapist, so that they can be certified as being able to do an effective job. National boards set up and supervised by the AAIT's sponsoring societies would be one answer. This would help us to establish standards of ethics and effective treatment.

So we have considered benefits derived from the standards maintained by the manufacturers of equipment; the effectiveness of standard methods of procedure; and our hopes for better patient care through a more standard training and evaluation of personnel.

Each of us should seize every opportunity that comes to him in his own institution to advance the cause of inhalation therapy (and thereby the quality of patient care) by trying to reduce the confusion and inefficiency caused by lack of standardization. This is best done by simplifying equipment and by developing procedures for each kind of therapy and then acquainting all concerned personnel with the procedures.

James E. Peo

ETHICS AND QUALIFICATIONS FOR AN IDEAL INHALATION THERAPIST

By SISTER M. YVONNE, F.S.P.A., R.N. B.S.*

Inhalation Therapy has advanced greatly since the days when a half drowned man was rolled over a barrel to empty his stomach, and pummeled on the ribs to start his breathing. Advancing with medical science, it has become a highly technical field — specialized, true, but nonetheless retaining its ties with other medical branches.

The lure of Inhalation Therapy and its fascination to those in this field lie often in the variety of this work. The problems with which it challenges one's ability are almost endless; they arise not only from the actual equipment and techniques but also from the physical status of the patient, as well as the special demands of individual physicians. The wide variation of reactions to the various techniques of administration demands a constant alertness on the part of the Inhalation Therapist. He must combine skill with experience, for both are essential to success.

Qualifications

The specific qualifications of a good Inhalation Therapist are many. Basic, of course, is a general, all-around competence. No one can have confidence in an obviously blundering type of person. Another is alertness. The therapist should be wide awake and quick thinking. Furthermore, he must be conscientious and careful in the work; administering the thousandth treatment just as well as the first, and at all times concentrating on the case at hand.

A good Inhalation Therapist must be up to date in the field. This is done by maintaining contact with the latest books and periodicals, and through hospital visits, conventions and institutes keeping an open mind to the ideas of others in the field. The therapist should not, however, limit himself to knowledge of Inhalation Therapy only but should try to possess a maximum knowledge of such allied subjects as general medicine, surgery, pathology, pharmacology, psychology, anatomy, physiology, and other branches of therapeutics. Being well read in other areas such as the liberal arts, will be of great aid in sustaining a diverting conversation with patients, thus transferring thoughts from fear of the coming ordeal to some topic of interest. Such reading will also be of value to the therapist personally, enriching enjoyment of life.

The Inhalation Therapist must be a keen observer to monitor the effects of the therapy on the patient. Good judgment must be used

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***Sister M. Yvonne is Director of Anesthesia at St. Francis Hospital in La-Crosse, Wisconsin. She is a member of the Board of Directors of the American Association of Inhalation Therapists and this article is adapted from a talk she presented at the Association's annual meeting held November 4 through 8 in Cleveland.**

in working with each case. He must at all times, and under all provocations remain calm, so as to inspire the confidence of both the physician and the patient. He must be sympathetic with both of these, and as a sort of middleman, make every effort to get along with them. The therapist must always be understanding, explaining to the patients, in advance and as the treatment progresses, each step of the therapy. A genuine interest must be shown for each patient as if he were a close relative, as indeed he is in the family of God. This is applicable to all sorts of patients, be they old or young, crabby or cheerful, black, yellow, white, or should it occur, green.

The therapist must always maintain a pleasant personality. The provocation to shortness of temper, impatience, irritability, and a distracted mind during times of difficulty may be great, but the therapist must remember that the patient is probably very frightened, undoubtedly nervous, and certainly in need of much reassuring. By putting one's self in the patient's place, one will more readily perhaps understand the problems, and the task of encouraging the patient will be made easier.

Perhaps it would be well if we dealt a bit more at length with the emotion of fear, for that will be encountered consistently by the Inhalation Therapist. Fright, fear, and anxiety are closely related, differing from each other mainly in intensity and duration.

The effects of prolonged anxiety on the physiological functions of the body are well known, and should be of particular interest to the therapist. Anxiety is capable of causing profound changes in the blood pressure, heart rate, capillary permeability, minute volume output of the heart, blood flow, rate and depth of respiration, and carbon dioxide content of the blood; all of which seriously affect the patient's physical reaction to Inhalation Therapy.

Further, during periods of emotional tumult, muscular contraction shortens the diaphragm, making it difficult to draw a long breath. Ventilation is markedly modified, leading to sighing respirations. Also, almost any cardiac arrhythmia may occur as the result of emotional stress. One of the most basic of fears encountered is that of suffocation, not being able to breathe. This is oftentimes associated with the sight of the mask. The patient may have memories of the time when an oxygen tank was wheeled into the room only as a last, desperate resort, as well as other unfortunate experiences. Modern Inhalation Therapy is so new that for the great majority of patients the procedures are totally unfamiliar; they understand neither the equipment, the procedures, nor the effects they may expect to feel upon themselves.

Intellectually the patient may realize that his fears are groundless, but unfortunately fear is not controlled by reason. It is an emotion and when aroused, it is not subject at all to voluntary control. Therefore it is up to the sympathetic and understanding therapist to work with the patient, help him find outside strength to face what is for him an ordeal, and allay the fears which overwhelm him.

The Inhalation Therapist must keep in mind that he is dealing

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American Association of Inhalation Therapists

CODE OF ETHICS

Preface

The professional calling of the Inhalation Therapist is the dedication of unselfish, loving, and intelligent service in treating conditions associated with respiratory pathology. An appointment to continue the work of healing which Christ began on earth, it is based on ethical values which have as an end the ultimate good of the whole person, regardless of race, creed, nationality, or economic status. These ethical values are set forth in a professional code based on the natural moral law which all members are obliged to observe. This demands personalities of intelligence and integrity further developed by education and professional training to a realization of rights and duties in regard to the profession, the physician, the patient, the employer, associates, and the public.

Although the private life of the Inhalation Therapist is not proper matter for a professional ethical code, it must be remembered that no action, while on duty or off, can be divorced from the reputation of the profession as a whole.

The Profession

1. The fundamental aim of the medical profession is, in all instances, to conserve life and promote health. The knowledge and services of the Inhalation Therapist must be used solely for the achievement of this aim.
2. Inasmuch as scientific research daily contributes to the improvement of methods, techniques, and materials, the Inhalation Therapist has the obligation to promote his professional competency through continued study, observation, and investigation.
3. Membership in the American Association of Inhalation Therapists indicates proper professional interest on the part of the Inhalation Therapist.
4. The Inhalation Therapist should maintain personal habits of grooming and conduct which are in keeping with a professional status thus inspiring respect and confidence.
5. The professional therapist holds in strict confidence all information of personal or private nature.

The Physician

1. The Inhalation Therapist has the obligation of conscientiously implementing the physician's orders in the administration of Inhalation Therapy. The legal and professional responsibility rests with him.
2. The Inhalation Therapist has the obligation of providing the physician with intelligent, alert, and progressive service, in the sense of keeping up with the latest techniques.

The Patient

1. The Inhalation Therapist renders service to the patient as one in need of professional ministrations; the therapist, therefore, transcends such things as ethnological, religious, and economic considerations.
2. In every relationship with the patient, the Inhalation Therapist should manifest a knowledge of human relations, demonstrating a spirit of kindness, gentleness, patience, and understanding sympathy.
3. The Inhalation Therapist is responsible for competently and efficiently administering the therapy prescribed.

The Employer

1. The Inhalation Therapist should seek employment on the basis of professional qualifications only.
2. Contracts (written or oral) made by the Inhalation Therapist with the employer are to be fulfilled in letter and in spirit. Changing circumstances may justify subsequent requests for modification of the agreement.
3. The Inhalation Therapist may justly expect that statements regarding the quality of his work will not only be true but confidentially given and received by his employer.
4. The Inhalation Therapist has a right to a just remuneration for his services; acceptance of additional compensation is unprofessional.

The Associates

1. The Inhalation Therapist should always be courteous to associates, according them understanding, help, encouragement, and loyalty; the therapist should be especially interested in the development of younger workers.
2. In the practice of the profession the Inhalation Therapist should disclose procedures which are incompetent and dishonest to proper authorities; the therapist should at all times avoid unfavorable comment about associates to others.

The Public

1. The Inhalation Therapist should realize that he has an obligation, by virtue of his citizenship, to the community as a whole. The therapist should conscientiously fulfill the duties of a citizen by participating in community planning and promotion of good public relations.
2. The Inhalation Therapist has an obligation to share the knowledge and skill of the profession with others who are working for the common good. The cause to be served must supercede the private good of the Inhalation Therapist.
3. Although an Inhalation Therapist should exercise the right to give constructive criticism, he should be loyal to his profession, his organization, and his community.

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not primarily with oxygen, carbon dioxide, helium, and machines, but with thinking, feeling, living human beings, people who in addition to having heart trouble and various types of lung disorders, have worries, fears, anxieties, and other emotions.

The question arises, how does one help a patient overcome fears? It cannot be done merely by telling him not to be upset. This adds to the burden; he must then pretend he is not afraid.

Neither is reasoning with him the answer. As previously stated, fear is not a reasoning thing. The patient will only feel misunderstood. This, however, is not to say that the procedures must not be explained to him, simply, in a manner which he can understand. For if he can be prepared to follow each step in his treatment his fear of the unknown will be lessened, and he will be less likely to fight the help the therapist is trying to give.

The other psychological aid the Inhalation Therapist can give a patient is equally simple. He must be a good listener. Here, as in all of life, the most important thing for the therapist to remember is the old, tried and true Golden Rule. For who among us has never felt fear, and from this fear, known what is needed.

Ethics

The role of the Inhalation Therapist in the life of the patient is important. As an individual administering therapeutic gases, and various kinds of positive and negative pressure treatments, etc. one is able to bring about marked changes in the human body. Is the therapist then a law unto himself? Or are there principles and standards which should guide one's actions in relation to the patient?

To the man of Faith, the dual nature of man and his sublime destiny are evident realities. So, too, is the respect due each and every human being. So true is this that planted deeply within the rational nature of each man is the injunction "Do good and avoid evil." This is the universal formula by which order is maintained in the moral universe. It is an objective norm of morality; the basic principle of the Science of Ethics. "Do good and avoid evil" is the criterion by which the quality of the human act is measured. If an act conforms to the norm, it is moral; that is, according to right reason; if not, it is immoral, not according to right reason. The law of reason is the natural law implanted in the mind of every man by God.

What does correct reasoning dictate as an ideal in the matter of right and duty for the Inhalation Therapist? Benjamin Brodie probably sums it up when, speaking to his students over one hundred years ago, has said, "Let me exhort you never to slur over a single case, nor proceed to the most minor treatment without having well considered that accidents may happen, what evils may follow, and what degree of danger may ensue."

Obviously, this quotation is not sufficiently detailed to inform an Inhalation Therapist of any ethical obligations toward a patient. For this reason a Code of Ethics has been drawn up specifically for this area of the medical field.

IPPB—

The Equipment and the Physiologic Effects

By David Gillespie, M.D.

Intermittent Positive Pressure Breathing (IPPB) has been around for nearly a decade now, and we don't know all the answers about it yet. We don't know exactly where it is going to fit into our armamentarium, but it is a method by which positive pressure is exerted to the upper respiratory system on inspiration only. It has been introduced to administer bronchodilators, and it has aided in the administration of oxygen, and does assist in increasing ventilation.

The equipment is produced by many different companies, and I have had occasion to use almost all of the different machines. I have found most of the equipment and the companies quite reliable.

Equipment Components

The component parts of IPPB consist first of a source of positive pressure. By and large, the commonest source is a large cylinder of compressed gas. This will ordinarily provide about 25-30 treatments of 15 minute duration. The gas commonly used is oxygen. Some of the equipment incorporates a diluter mechanism which will permit longer use of a given cylinder and allow a lower operating cost.* In a few instances, compressed air is desired where oxygen has adverse effects, resulting in lower ventilation.

There is also equipment which can be attached to piped oxygen, and there are units available in the form of pump compressors which will supply the source of pressure. These compressors have to be adequate to follow inspiration, and should have available volumes of up near 100 liters a minute when demanded.

In evaluating various types of equipment the most important areas to consider are the two valves —the demand (inspiratory) valve and the expiratory valve. The very earliest equipment had demand valves which were difficult to initiate. Most of the recent equipment and some of the earlier models have been improved so that the demand valve can be tripped by only a slight inspiratory effort on the part of the patient. Most apparatus now has a manual method of initiating

* Ed. Note: However, with some units the flow of gas from the cylinder is the same in all cases, dilution being accomplished simply by adding more or less air to the oxygen as it passes by the diluter. Hence no gas economy can be effected with this type of diluter.

Another interesting observation related to the operation of this sort of diluter is that the total gas available at the mouthpiece to meet the patient's demand is consequently far greater at maximum dilution than it is when using 100% O_2. This is ironic because the most dyspneic patients—for whom it would be desirable to use 100% O_2—often find that the undiluted flow is inadequate to meet their peak inspiratory demand, and it is necessary to open the diluter to 60% in order to entrain enough air to make up the lack.

positive pressure, and on some of it automatic cycling is available if desired.

The exhalation valve is an important factor. It is essential that it be kept near the patient, because the farther away it is placed, the more common tubing is required for inspiration and expiration, and a larger increase of dead space and less effective ventilation for removal of CO_2 results. The valve should be easily cleaned and maintained.

A unit for determining the point at which positive pressure will be stopped is also a component of this equipment. This generally consists of a pressure setting device, which incorporates a gauge that will tell the maximum pressure which you have set it to apply. However, it is better to rely for the final setting of the pressure adjustment upon the mask pressure gauge when the equipment is in actual usage. The usual pressures which are employed are in the range of from plus 15 to plus 20 cm of water. However, on the initial treatment, it is commonly used at a lower pressure until the patient develops some tolerance and understanding of the equipment.

Another important component of the IPPB equipment is the nebulizer. This is a unit which will provide a dispersion of very fine particles in the gas, so that medicaments and aerosol therapy can be transported by the IPPB down into the lungs. It is important that this nebulizer be placed as near the patient as possible. The machines vary in their operation; some nebulize continuously, others only during inspiration. This will have advantages for some patients, in that if the tidal volume is very small continuous nebulization is to be desired; but if the tidal is adequate, intermittent nebulization will save a little money in expenditure for drugs.

There is a needle valve in most of the equipment which is used to set the flow of gas through the nebulizer, so that the rate of nebulization will be that which (within limits) will accomplish the amount of medication wanted in the time prescribed.

The way in which the patient is connected to the apparatus is also of some importance. Most machines have available either a mask or a mouthpiece, and there is at least one which has means for attaching to a tracheotomy tube. In our experience, the mouthpiece is more usable, and for this reason: it is less likely to leak than a mask, and the added dead space is smaller, so that it doesn't reduce the effectiveness of the ventilation as much as some masks do. Masks are essential, however, for uncooperative patients; and the tracheotomy attachment is of definite value when you are trying to use IPPB for postoperative thoracic surgery patients with tracheotomies, or perhaps patients who have had tracheotomies for multiple rib fractures or polio.

Effects on the Respiratory System

The physiologic effects of IPPB are essentially equivalent to those produced by iron lungs or chest respirators, where negative pressure is used outside the body. The effect of positive pressure in the lungs is physiologically nearly the

same as negative pressure around the body. This effect on the respiratory system is to increase ventilation by increasing the depth of breathing. It will reduce the work of inspiration if the patient is willing to relax and cooperate with the machine.

Except when IPPB is used over a longer period of time to eliminate CO_2, some form of aerosol therapy is usually employed along with it, and water vapor is always used if no medicinal agent is placed in the aerosol equipment. When aerosol bronchodilators are combined with IPPB, there is a variable increase in ventilatory function in about half of the patients I have used it on.

This will be evidenced by an increase in Vital Capacity, and by an increase in ability to empty air rapidly—or Timed Vital Capacity. Patients will also show improvement in Maximum Breathing Capacity. The amount of improvement which occurs varies considerably from patient to patient. In those who have demonstrated objective improvement, there is generally a slight to moderate improvement of shortness of breath on exertion. Usually the maintenance of these improvements depends on a continual program of IPPB and bronchodilators; however, the frequency of treatments may gradually be reduced, and supplements of bronchodilators via hand nebulizers are frequently used in the home.

Improved Cough

Another very important action on the respiratory system is the fact that IPPB with bronchodilators has a beneficial effect on the cough mechanism. Those people with diffuse narrowing of the airways frequently have trouble with retained secretions, and in this group, IPPB will often allow better aeration of the lung behind some of these secretions, and will permit a much more effective cough, resulting in increased sputum production, and a sensation on the part of the patient of being "opened up" and having an improved ability to breathe.

Dr. David Gillespie is on the staff of Cleveland City Hospital, Cleveland, Ohio. This article is an adaptation of a talk presented at the Annual Meeting and Lecture Series of the American Association of Inhalation Therapists in Cleveland in November, 1957.

Effects on Circulatory System

There is an effect of this procedure on the circulatory system, however, which by and large is not important; but when dealing with impaired circulation may be a factor to reckon with. There is less than atmospheric pressure surrounding the lungs in the thoracic cage. This ordinarily is a negative pressure, which increases during inspiration. This negative pressure is favorable to the return of blood from the body to the heart. When IPPB is used, during inspiration we now have a **positive** pressure in this area, and this tends to impede the flow of blood back to the heart.

When we're dealing with a **normal** circulation, adjustments to this are easily accomplished and in the normal individual, this is no significant problem.

However, in people who have impaired circulation, either due to incipient or minor degrees of be-

ginning failure of the right heart, or due to loss of blood volume, or due to presence of shock, or due to loss of control of vasoconstriction, such as after spinal anesthesia — these people are unable to make the proper adjustment in vasoconstriction, or are unable to maintain a further elevation in venous pressure, and in some of them there will be a reduction of cardiac output, a fall of systemic blood pressure and a slowing of the circulation which may cause more difficulty than the benefits derived from the IPPB therapy.

Dr. Feinsilver in Kansas ~~City~~ reported last spring on a study of circulatory complication incidental to IPPB in nine patients. He intimated that there was in his experience a fall of blood pressure in all of them, and a prolongation of the circulation time (determined by dye dilution method). He also stated that in one instance there was a rather severe syncopal attack and a loss of pulse. However, this has not been our experience in several years of using IPPB, and I believe that if we keep this potential danger in mind and do not use pressures which are high or prolonged during the cycle of respiration this effect is minimized. However, when you do have cases of impaired circulation, it is much better tolerated by those patients to have a positive-negative cycling device rather than IPPB to assist ventilation, and this applies whether this is a mouth device or a tank respirator which is doing the cycling.

Applications of IPPB

IPPB is a very convenient way to administer aerosol therapy with bronchodilators and other agents. We have used Alevaire, we've used antibiotics for specific bronchial infections (though parenteral therapy is the more common route for us), and the proteolytic enzymes can be nebulized with IPPB to digest thick tenacious secretions.

Another use which should be considered is the control of paradoxical motion of the chest wall in those people who have had multiple rib fractures, or who develop this motion after thoracic surgery. IPPB will minimize the amount of paradoxical motion, and will allow the patient to tolerate the situation better.

We can also use it to increase ventilation in people with respiratory acidosis. However, we frequently try instead the use of bronchodilators and a graded oxygen therapy (i.e., gradually increasing concentration) as indicated by Drs. Barach and Andrews.

We've had the unfortunate experience of having four patients with respiratory acidosis recently, however, in whom we initiated one liter flows of oxygen by catheter, and who progressed rapidly within a matter of 10 or 12 hours to profound respiratory acidosis, and in some, marked circulatory failure. However, these persons when placed in a cycling respirator have shown improvement—some of them temporarily only, but with one or two of them a more permanent type of elimination of the acidosis was achieved.

Contra-Indications to IPPB

The contra-indications for the use of this therapy are:

(1) Those who have air leaks such

(Please turn to page 30)

Gas Pressure Regulators

By WAYNE HAY*

THE gas pressure regulator is the key to the proper functioning of any gas consuming apparatus, and is indispensable for many operations using compressed gas. Both types of gas regulators, direct and indirect, are discussed in this article and a diagram of each is shown. Static and dynamic balance are differentiated and the advantages of multiple regulators are described.

A simple gas pressure regulator is a device which permits the expansion of a gas from a relatively high but variable pressure to a lower but nearly constant pressure at a rate equal to the demand within the limits of its capacity.

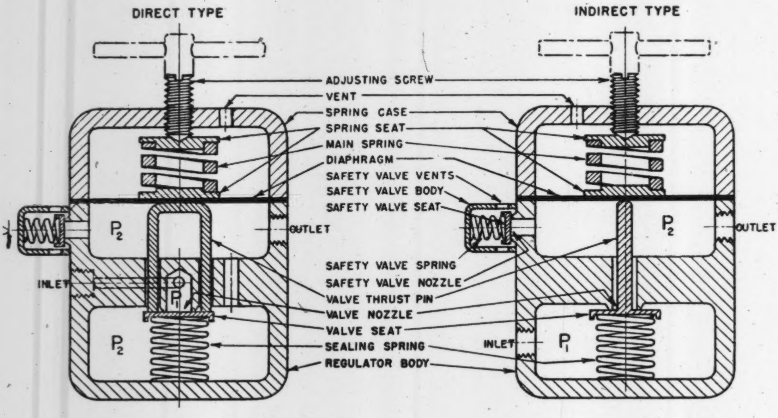
There are two distinct types of gas pressure regulators. These are called "direct" and "indirect" regulators, the distinction lying in the direction in which the unregulated or inlet pressure is exerted upon the regulator valve. That type of regulator in which the closure of the valve is opposed by the inlet gas pressure is called the "direct" type, and that in which the closure of the regulator valve is assisted by the unregulated or inlet gas pressure is called the "indirect" type. Both types fulfill the same function as set forth in the above definition but differ in details of operation.

A regulator may be regarded as a mechanism which is perpetually striving to achieve a balance between several changing forces. These forces, all mechanical in nature, may be exerted by weight, springs, levers, gas pressures, friction or nearly any other means either individually or in combinations. The operation of a regulator is limited in the degree to which it can achieve a balance between these forces and the range of flow and pressure over which such balance can be achieved.

Static Balance

Direct Type — (Refer to drawing) — The drawing shows only the essential parts of the regulator. The adjusting screw in the spring case is designed to compress the main spring between the two spring seats forcing the lower spring seat against the diaphragm. The diaphragm is a thin, flexible, gas-tight membrane which transmits this spring load to the valve thrust pin. The latter is guided vertically in the regulator body so that its lower end bears against the valve seat, which is biased against the nozzle by the sealing spring. Let us assume that the adjusting screw has been turned to release the load in the main spring, allowing the sealing spring to seal the valve seat against the valve nozzle, and that the inlet of the regulator is connected to a source of gas

*Product Engineer, Ohio Chemical & Surgical Equipment Company. Reprinted with permission from Ohio Chemical Anesthesia Items, November, 1956.



under high pressure through a valve which is closed. Let us further assume that the outlet is fitted with a valve which is likewise closed.

When the valve between the source of high pressure gas and the regulator inlet is opened, the gas under this pressure, which we shall call P1, will enter the inlet and pass through a hole into a cavity above the valve nozzle, exerting a force on the valve seat which tends to open it. (The inlet hole does *not* connect with the thrust pin guide holes.) This force is more than counter-balanced by the force of the sealing spring tending to close the valve. The difference between these two forces equals the actual load which is applied to the rim of the valve nozzle by the valve seat.

Let us now turn the adjusting screw to compress the main spring against the diaphragm. When this compressive force has exceeded the force which the valve seat exerted on the valve nozzle after gas was admitted to the inlet, the valve seat will move away from the valve nozzle, permitting gas to expand between them into the cavity surrounding the sealing spring as well as through the valve thrust pin guide holes shown, and into the space below the diaphragm. Here it will be trapped and will increase in pressure until it exerts enough force on the diaphragm opposing the force of the main spring to permit the sealing spring to seal the valve seat against the valve nozzle, at which point no more gas will flow through the valve and the regulator will have reached a condition of static equilibrium.

Indirect Type—(Refer to drawing) — This type is identical with the direct type down to and including the diaphragm, below which the valve thrust pin projects through a hole terminating in the valve nozzle and carries on its lower end a valve seat which is biased in the direction of the valve nozzle by a sealing spring.

Let us postulate the identical starting conditions as used above with the Direct type. Then, when

the valve between the regulator and the high pressure source of gas is opened, the gas will enter through the inlet into the cavity surrounding the sealing spring and valve seat but will go no further. In this case its own pressure P1, distributed over the area of the valve nozzle, assists the sealing spring in keeping the valve closed.

Turning the adjusting screw to cause the main spring to exert a load on the diaphragm will eventually result in a main spring force exceeding the total of the sealing spring force and the force due to the pressure of the inlet gas over the area of the valve nozzle. Under these conditions the valve seat will move away from the valve nozzle, allowing the gas to expand through the nozzle along the valve thrust pin and into the cavity under the diaphragm. Here it will be trapped and will increase in pressure until it exerts a force on the diaphragm which, in combination with the forces of the sealing spring and the inlet pressure, will lift the diaphragm against the force of the main spring to permit the valve seat to seal against the valve nozzle, stopping further flow and introducing the condition of static equilibrium.

Dynamic Balance

Initial Establishment of Dynamic Balance—Both the direct and indirect types of regulator achieve the initial conditions of dynamic balance in the same manner. Let us assume that each is connected to the same source of high pressure gas and that both are in the condition of static equilibrium.

Now let us open the outlet valve, permitting gas to escape from the cavity under the diaphragm, decreasing the pressure exerted on the diaphragm, and allowing the mainspring to depress the diaphragm and the valve thrust pin, moving the valve seat away from the valve nozzle against the pressure of the sealing spring, and permitting gas to expand through the valve and into the cavity under the diaphragm. This movement of the diaphragm, thrust pin, and valve seat will continue until the valve opening is sufficient to permit a flow of gas exactly equivalent to the demand at the regulator outlet, establishing dynamic equilibrium. It will be noted that the movement of the diaphragm has permitted the main spring to extend, reducing its force on the diaphragm.

Opposing the mainspring force is the force of the sealing spring which has increased due to its compression, and the force of the regulated pressure P2 over the effective area of the diaphragm. It is obvious that the force due to the reduced pressure P2 over the effective area of the diaphragm now is smaller so that the sum of the forces in both directions are equal. Thus it is that the reduced pressure P2 under dynamic equilibrium conditions becomes smaller than under static equilibrium. The difference in pressure is called static increment. It is obvious that the static increment increases as the rate of flow increases, because a greater flow will require a greater movement of the valve seat, valve thrust pin, valve and diaphragm, resulting in a greater loss of mainspring force.

Static increment is the increase in regulated pressure which results

when the rate of discharge of a regulator is reduced to zero from any given value.

Progressive Change in Conditions of Dynamic Balance—Direct Type – The combination of diaphragm, valve thrust pin, and valve seat is in balance between two sets of opposing forces. In the direct type of regulator it is biased toward sealing by the force of the sealing spring and the force of the regulated pressure P2 over the effective area of the diaphragm. Balancing the combination in opposition to these is the force of the mainspring and the force of the inlet gas pressure P1 exerted over the area of the valve nozzle. As the gas supply of the high pressure source is exhausted the inlet pressure P1 will decrease, resulting in a reduction of the unsealing forces which must be counter-balanced by a reduction in the sealing forces. Since the force of the sealing spring does not decrease, it is obvious that the regulated pressure P2 must decrease in order to achieve this balance. It is therefore obvious that the maintenance of dynamic equilibrium results in the automatic diminution of regulated pressure P2 as the inlet pressure P1 decreases. It is also obvious that this diminution of regulated pressure P2 will be greater if the ratio of the area of the valve nozzle to the effective area of the diaphragm is increased.

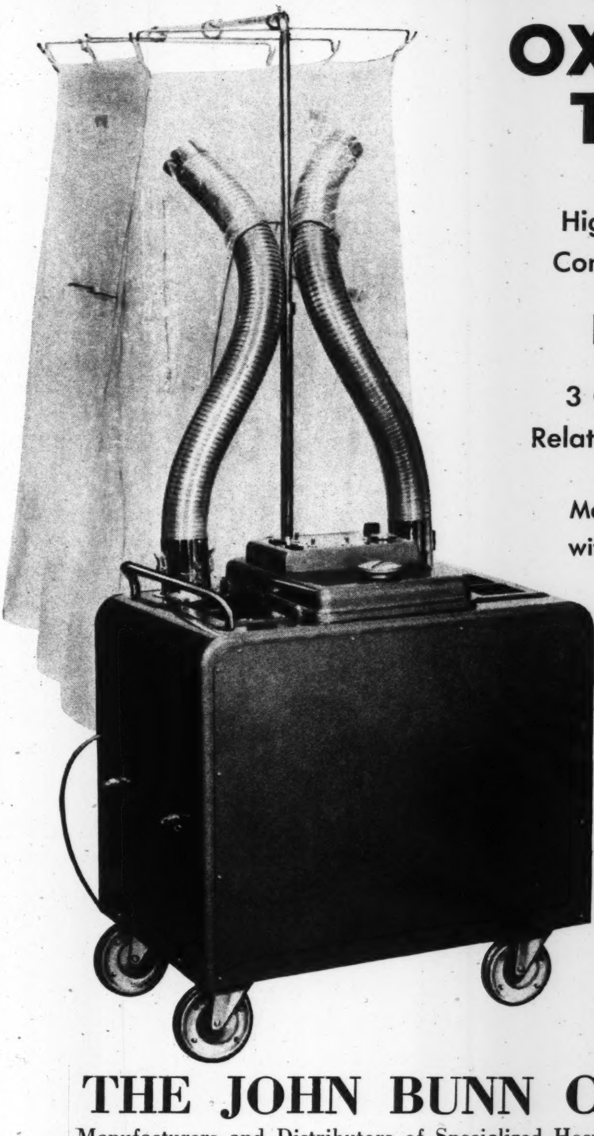
Indirect Type—In the indirect type of regulator the combination of diaphragm, valve thrust pin, and valve seat is biased toward sealing by the force of the sealing spring, the force of the regulated pressure P2 over the effective area of the diaphragm, and the force of the inlet gas pressure P1 over the area of the valve nozzle. Balancing these is the force of the main spring. As the gas supply is exhausted, inlet pressure P1 will decrease and it will be necessary for the regulated pressure P2 to increase to maintain the balance. It is therefore obvious that the maintenance of dynamic equilibrium results in the automatic increase of the regulated pressure P2 as the inlet pressure P1 decreases. As in the case of the direct type, the change in regulated pressure P2 will be greater as the ratio of the area of the nozzle to the effective area of the diaphragm is increased.

Multiple Regulation

To increase the accuracy of pressure control it is customary to use two regulators in series, the first being supplied from the cylinder (or other source) and the second from the output of the first. In this manner the delivery pressure from the latter is held much more constant for a given rate of flow, since in effect its source of supply varies only slightly in pressure as the cylinder pressure changes greatly.

This arrangement, called two-stage regulation, is often used to increase flow capacity without sacrificing pressure control, since larger valve seats can be used for a given diaphragm size than with a single stage regulator.

Two- or even three-stage regulation is used in regulators designed to supply gas at breathing rates and pressures, since the valve of the last (or breathing) stage must often be too lightly constructed to support the pressures found in the source of supply.



CHAPTER ACTIVITIES

By Jack Sangster

At its December meeting, the **Greater Montreal Chapter,** meeting at Royal Victoria Hospital, saw Ohio Chemical's filmstrip "Oxygen Therapy in Diseases of the Heart and Lungs." Mr. Flemming of the Canadian Liquid Air was thanked for his translation into French of the Code of Ethics for Inhalation Therapists.

Dr. Guy Fortin of Notre Dame Hospital has consented to be advisor to the chapter, and is presenting an invitation to sponsor the chapter to the Quebec Division of the Canadian Anesthetists' Society.

The **Greater New York City Chapter** held its annual meeting on January 24th and elected the following officers: President, E. Rocco Cioffoletti, New Rochelle Hospital, N.Y.; Vice President, Carl Crandall, Roosevelt Hospital, N.Y.; Secretary, Benigno Rosa, New York; and Treasurer, Homero Rosado, New York.

The **Illinois (Alpha) Chapter** held its first Annual Clinic at the Alexian Brothers' Hospital in Chicago, January 28-30. The 3-day session of lectures and demonstrations was attended by over a hundred persons from the area, and was judged a highly successful venture. Physicians addressing the group were Drs. Albert Andrews, David Cugell, Edwin Levine, Max Sadove and George Saxton of Chicago, and Dr. Clifford Kalb of Milwaukee.

New officers are: President, J. Addison Young, of MacNeal Memorial Hospital, Berwyn; Vice President, Wilmetta Merchant, of Franklin Blvd. Community Hospital, Chicago; Treasurer, Edward Leveille, of St. Luke's Hospital, Chicago; Secretary, Lawrence Fruik, of Edgewater Hospital, Chicago; and new Board member (2 year term), Robert Kruse, of AAMED, Inc., Oak Park. The other Board member (1 year remaining) is Sister Mary Arnoldine, of St. Elizabeth's Hospital, Chicago.

The **Florida Chapter** has purchased a tape recorder for educational purposes. Tapes of various addresses made at the annual meeting last November have been played for the benefit of those who were unable to go to Cleveland, and it is planned to play them for other interested groups in the area.

The new officers for this year are as follows: President, Norman Rush; Vice President, Melvin Hall; Secretary, Arvil F. Baker; Treasurer, George Boewig; Sgt. at Arms, Warren Gariepy.

Two new members have been added to the Board of Advisers, namely Dr. George Baum of the VA Hospital in Coral Gables, and Dr. J. G. Converse, Head of the Department of Anesthesiology at Jackson Memorial Hospital in Miami.

Western New York Chapter held its annual meeting January 20 at Veterans' Administration Hospital in Buffalo. Speaker was Dr. David

Greene, of the University of Buffalo, who spoke on IPPB vs ASB (Alternate Suck & Blow) Resuscitators. This led into enthusiastic discussion of mouth-to-mouth breathing vs artificial respiration by manual methods.

The chapter has invited the Greater New York Chapter to participate in a joint meeting in some city between New York and Rochester.

Officers for this year are: President, James Whitacre, of University of Rochester Medical Center; Vice President, LaVerne Schaut, of Veterans' Administration Hospital, Buffalo; Treasurer, Ed Lang, of Greene & Kellogg, Buffalo; Secretary, Mrs. E. Ruth Mullen, of Millard Fillmore Hospital, Buffalo; Board Member (2 year term), Dan Brittain, of University of Buffalo Medical Center; and Board Member (1 year term), Herbert Schuck, of Buffalo General Hospital.

IPPB

(Continued from page 18)

as pneumothorax due to a bronchopleural fistula. I do not believe that blebs or cysts are a contra-indication; we have treated many people with them without any coincidental air leaks—I believe that when you can see a cyst, generally it is beyond the period when it is likely to rupture.

(2) For those patients who have **cor pulmonale** or are in right heart failure, it is better to use a cycling positive-negative system of respiratory assistance.

(3) Those who have circulatory instability—either due to blood loss or shock or spinal anesthesia.

(4) There is a **relative** type of contra-indication to the use of large doses of bronchodilators in people who have hypertension or coronary artery disease.

Value of Pulmonary Function Tests

In our hospital experience, we have all the thoracic surgery patients and all the patients coming to surgery who have history of extensive pulmonary disease sent to our department for evaluation.

We also have a number of persons who are short of breath and in whom the cause is not understood, and in whom the respirator system is only suspected. We have some who are referred to our service because of X-ray findings suggestive of emphysema.

These patients may or may not have limitation of function. Understandably, the referring physician wants everything possible done to alleviate the dyspnea. I would again make the plea that before plunging into a regimen of therapy which may or may not help the patient, a series of pulmonary function tests should be done. If at all possible, at least Timed Vital Capacity and Maximum Breathing Capacity determinations ought to be made, and the results interpreted in concert with other data from the patient's medical history. These studies will lead to a much more rational employment of inhalation therapy.

We routinely evaluate the effect of bronchodilators and IPPB in those people who have evidence of slowing of their rapid rate of exhalation; and on those who have an objective improvement, we continue the treatment. In those who do not, but do have a subjective improvement, we also continue the treatment for some time and then restudy them.

Dr. Sadove Consultant to Air Force

Dr. Max S. Sadove, Director of Anesthesia at University of Illinois Research & Education Hospital, and formerly of the AAIT Advisory Board, has been appointed this year's consultant to the U.S. Air Force. Even though he has left the Advisory Board, because membership in both our sponsoring societies precludes this, Dr. Sadove remains active in the inhalation therapy world, his latest contribution being lectures and demonstrations at the Illinois chapter's clinic in January.

Paris Oxygen Bar

Several newspapers late in the summer ran a little feature written by Roland Fullen, a *London Express* correspondent, who recounted his experiences in a Parisian restaurant where customers order oxygen as an aperitif instead of a cocktail. They lie on couches in shock position and receive oxygen by facemask for 15 minutes, then proceed refreshed to their meal.

This is an interesting variation on the practice started by a number of bars in this country in recent years, where oxygen was dispensed for the supposed purpose of curing hang-overs. What the proprietors of those establishments overlooked, however, was the stern injunction in small type on the label of every cylinder: "Federal Law Prohibits Dispensing Without Prescription."

Evidently the European authorities do not regard oxygen only as a drug, and can therefore condone this practice; but as far as we know, either of these uses of oxygen is illegal in United States.

Head of Puritan Dies

Since our last issue went to press, the Chairman of the Board of Puritan Compressed Gas Corp., Mr. Parker Browne Francis, died on September 13th in Kansas City at age 71.

Mr. Francis founded the Puritan company in 1913, and had been its president from 1932 until January of this year when he assumed its chairmanship. It is believed that he was the only one of the original founders of the medical gas industry still actively identified with that industry.

Religion in American Life

The postwar years have been characterized by an attitude of indifference towards faith, religion and the churches. There is a great need in the lives of every one of us for the acceptance of a belief in some Power greater than anything on earth.

Elsewhere in this issue there appears a Code of Ethics designed for professional inhalation therapists. It would be hard to imagine such persons being really successful in living up to this Code without having a firm faith. Faith takes time to grow, and can best be nurtured by regular attendance at the church of your choice.

New Four Way
Oxygen Therapy Mask

Above, with accessory positive pressure valve.

Below, with large bore tubing, no bag.

It's a universal mask because it can be used four ways: 1. *Reservoir* type mask; 2. *Straight Rebreathing* mask, by removing center valve cover between bag and face piece; 3. *Positive Pressure* mask, with accessory positive pressure valve; 4. *Supersaturated* oxygen therapy mask, with large bore tubing, no bag.

Fits any size face; imbedded wire inserts adapt mask to all facial contours. Has interchangeable valves, detachable bag, seamless reinforcements, exhalation shield for eyeglass wearers, stomach tube orifice. And the mask can be completely disassembled for sterilizing. Write for prices and descriptive literature.

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New Equipment

Nebulizer Whistles

A new nebulizer which generates particles in the effective therapeutic range of 0.5 to 3.0 micra at flow rates as low as 3 lpm has been introduced by the Ohio Chemical and Surgical Equipment Company. At normal pipeline pressure flow rates as high as 15 lpm may be used.

A tubing reducer is provided to allow the unit be used with a variety of inhaler tubing sizes and a built-in warning whistle tells of any obstructions in the outlet tube. The nebulizer may be attached directly to a flow meter or to a supply tube leading from a wall outlet. The unit has a nonbreakable plastic bottle and a body of non-corrosive metals.

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Aerosol Generator

Misto-O_2-Gen Equipment Company has introduced a new "Tepid Mist" high volume aerosol generator, which is adaptable to tents, masks or IPPB units. This does not produce steam, but an aerosol which is warmed to a thermostatically controlled temperature, preset at the factory. The heating element is not the submersion type, but is incorporated in the base of the unit. A pilot light indicates whether heater is on or off.

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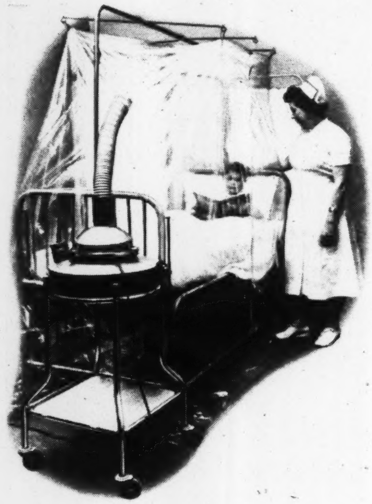
'TEPID MIST'



HUMIDIFIER

Mobile Humidity

Walton Laboratories, Inc. is announcing a new model of their famous mechanical humidifier for high humidity tent therapy. The unit comes on a mobile stand with canopy boom, hangers and canopies for use as a complete humidity tent, or may be used as a room humidifier or with oxygen tents. The manufacturer claims that its output is great enough to compensate for the moisture removed by the air conditioning system in electrical oxygen tents.

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ABSTRACTS

"Advantages of Glossopharyngeal Breathing," by J. R. Harries, M.D., in *Brit Med J*, 23 Nov 57.

Glossopharyngeal breathing (GPB), or "frog breathing," has been known for some time, and is being used to help respiratory paralysis victims to breathe without respiratory aids.

The process consists of forcing mouthfuls of air down through the larynx into the trachea, chiefly by movements of the tongue and throat muscles. A series of short gulps is necessary to get in enough air for one full breath, which is then exhaled in the usual manner.

By means of closing the larynx tightly between gulps, the lungs are gradually inflated by the air which is compressed a little more with each succeeding addition. This helps stretch the lungs, and improves the vital capacity very much. It also makes possible a more effective cough, because of the larger volume of air in the lungs to be expelled.

The method is used widely for polio patients, who after they have mastered GPB, are much freer of chest respirators, rocking beds, etc. Consequently, in addition to the physical improvements already noted, there is simultaneously a large psychological improvement as well.

The detailed technique for teaching GPB can be found in the *Manual of Instruction* published by the National Foundation for Infantile Paralysis.

"Ciliary Streaming in the Lower Respiratory Tract," by A. C. Hilding, in *Am J Physiol* 101:404, 1957.

Dr. Hilding, who has previously published papers on ciliary action in the nose, throat and sinuses, studied sections of the respiratory tracts of 50 cattle and 16 humans within a few hours after death, in order to determine the characteristics of ciliary activity. The cilia go on breathing for many hours after death (in some cases, 36 hours to 2 days).

Cilia are not found beyond the respiratory bronchioles, but with the exception of a few islands of non-ciliated cells, all the rest of the respiratory tract up through the larynx is ciliated. The cilia are overlaid with a blanket of mucus secreted by glands along the way, and their movement gradually advances the blanket upwards until it passes into the pharynx.

Since more mucus is added as the stream progresses upwards, the layer becomes thicker. The streambed itself narrows very much, being several meters wide at the source (the sum of the circumferences of the respiratory bronchioles), and only 50 mm at its upper end (circumference of the trachea).

By staining the mucus with India ink and observing carefully under a dissecting microscope, Hilding was able to study the direction of flow of the mucus, and the method of by-passing obstacles, etc.

He found that when the mucus blanket comes to the inlet of a branch bronchiole, it divides in the middle and half goes around each side. The two halves do not rejoin again downstream, as the entering mucus from the branch bronchiole flows in between them. At smaller openings, traction on the blanket probably accomplishes part of this; but at larger junctions (branches of the minor and major bronchi), Hilding found that the direction of beat of the cilia is actually responsible. That is, in these locations, the cilia do not beat in an axial direction as they do elsewhere, but at whatever angle is necessary to propel the thick blanket of mucus around the obstacles.

"A Method of Determining the Site of Retention of Aerosols within the Respiratory Tract of Man by the Use of Radioactive Sodium," by Timothy Talbot, M.D., Edith Quimby, Sc.D., and Alvan Barach, M.D. in *Am J Med Sci* 214:585 (1947).

"The effectiveness of aerosol administration in respiratory disease depends on the deposition of a maximum amount of drug at the diseased site. Two factors are of special interest: (1) the total quantity retained; (2) the pattern of distribution."

Retention is affected by size and density of particles, as well as by the hygroscopic properties of the aerosolized substance. The nebulizer used to generate the particles also influences their size.

In order to measure the amount of nebulized material retained, these investi-

gators incorporated 100 microcuries (the microcurie is a unit of measurement of radium emanations or other radioactivity) of radioactive sodium (Na^{24}) in each cc of physiological saline solution which was nebulized. Special nebulizers were designed with traps to catch the exhaled air. The subjects breathed only the oxygen coming to them through the nebulizer mouthpiece, and wore nose clips and exhaled through a side-arm of the nebulizer leading to the trap.

The radioactive sodium emits gamma rays through the body wall, so that its presence can be determined quantitatively simply by placing a Geiger counter against the chest wall. By measuring the amount of radioactivity left in the exhaled air that was trapped, and in the nebulizer residue, and subtracting these from the known amount put into the nebulizer to start, it can be ascertained how much went into the subject. Hence there are two means of seeing how much is retained.

Theoretically, the distribution of the substance could be roughly determined by moving the Geiger counter around over different sites on the chest wall; however, these investigators did not go into this aspect of the study in this preliminary report.

One of the interesting things they found was that the amount of aerosol retained was definitely greater when a hygroscopic substance like glycerine or triethylene glycol (they used the latter) was added to the fluid to be nebulized.

It is pointed out that inhalation technique and breathing time, as well as apparatus used, must be critically controlled if a comparative study is to be made.

"Respiratory Symptoms, Bronchitis and Ventilatory Capacity in Random Sample of an Agricultural Population," by I. T. T. Higgins, M.D., in *Brit Med J*, 23 Nov 57.

Working for the Pneumoconiosis Research Unit of the British Medical Research Council, Dr. Higgins surveyed a random sample of over 600 men and women in the Vale of Glamorgan, an agricultural area of Wales. The purpose of the survey was to compare the findings with those obtained in previous studies of miners, non-miners, those working in quarries, etc., with regard to incidence of respiratory illnesses, particularly chronic bronchitis, emphysema, and related disorders.

They found that the incidence of chronic bronchitis (defined as "persistent sputum and at least one chest illness during the past three years") rose in men from about 2% in the 25-34 age group to over 15% in those between 65 and 74.

In this study, smokers all had a higher prevalence of persistent cough and sputum than non-smokers. Furthermore, the male smokers all were more susceptible to chest illnesses and breathlessness.

In comparing rural men of age around 55-65 who were never employed in mines or quarries with a similar non-miner group living in an industrial city, Higgins found that the town dwellers were more liable to recurrent chest illnesses and chronic bronchitis than the rural group. Here the finger of suspicion is pointed at atmospheric pollution in the city; but consideration is also given to differences in smoking habits, etc.


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